Strategic Landscape Conservation Cooperative Partnerships Facilitate Species' Responses to Climate Change

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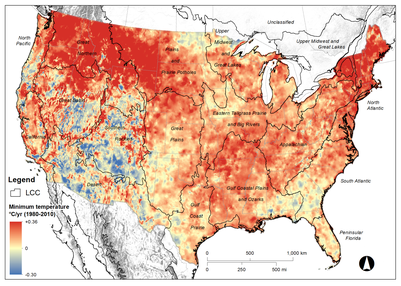
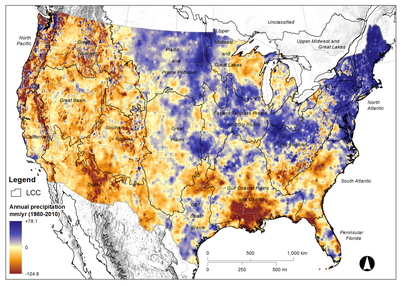
Abstract

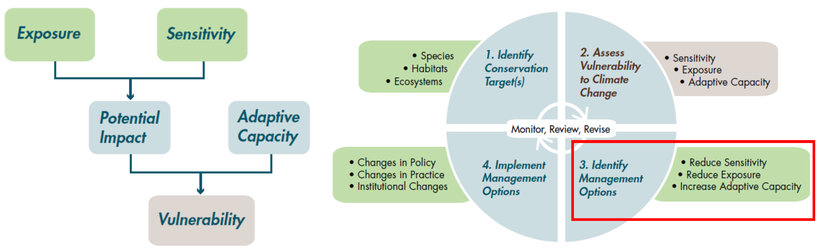
In the United States, Landscape Conservation Cooperatives (LCCs) encourage neighboring landowners to coordinate their resource management practices, thereby improving overall capacity of adaptation planning through increasing the effective sizes, latitudinal and elevational gradients, and connectivity of their individual management units. Focusing on such partnerships involving four major federal landowners in the contiguous US (Forest Service, Bureau of Land Management, National Park Service, Fish and Wildlife Service), we show that:

1. Focal agencies can increase their capacity 2 to 200-fold by coordinating activities,
2. Roughly 83-99% of these gains are attained when individual management units partner with just one other focal agency, and
3. Gains vary geographically by LCC among focal agencies and landscape metrics.

Results identify strategic partnerships within an existing protected areas network that create new and important opportunities for species to move geographically in response to climate change. We illustrate how results are informative for LCC planning at both national and regional scales.







LCCs are unique in how they have and will continue to experience climate change. Top left: Rate of change in minimum temperature of the coldest month, 1980-2010 (°C/yr). Top right: Rate of change in annual precipitation, 1980-2010 (mm/yr). Maps produced using 4 km resolution PRISM data.

In part due to these geographic differences in *Exposure*, LCCs also vary in their vulnerability to climate change. Bottom left: Conceptual model of how to compute climate change vulnerability. Bottom right: Overview of how to achieve climate change adaptation. The analyses presented here inform Step 3, *Identify Management Options* (red box), and assume all LCCs are highly vulnerable with respect to basic landscape features that enable species to move in response to climate change. Models from Glick et al. (2011) *Scanning the Conservation Horizon*.

Background

Species are attempting to adapt to ongoing changes in climate through complex networks of protected areas that are managed in various and sometimes competing ways for biodiversity.

In the United States, these adaptations may be encouraged under recently established Landscape Conservation Cooperatives (LCCs; US Department of Interior, Secretarial Order 3289), which are designed to foster the co-management of shared resources across landownership boundaries.

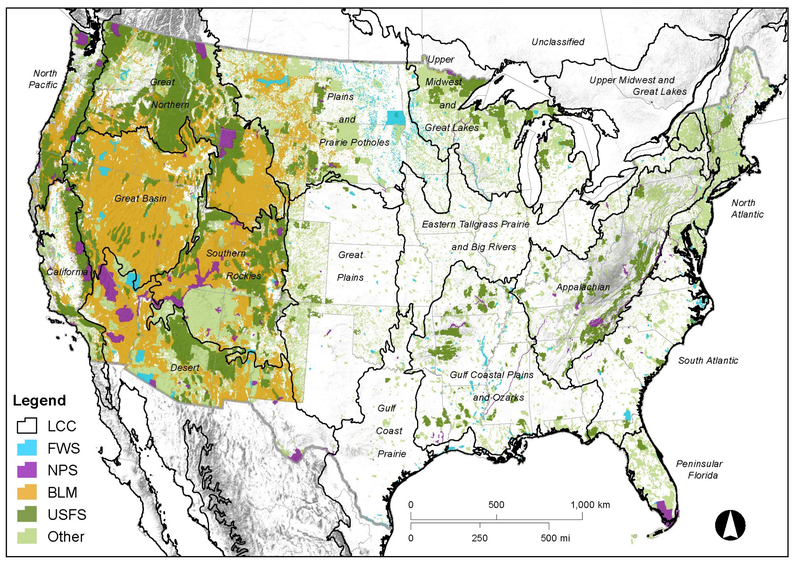
Although the species that serve as conservation targets can vary dramatically across LCCs, we know from past theoretical and empirical research what landscape features are required to preserve the basic biological processes that enable most species to track changes in climate:

- Area – where either below a size threshold certain species are unable to maintain minimum viable populations, or as a consequence of geographic shifts in an ecological niche a species is ecophysiologically 'pushed' into other areas that lack sufficient habitat or resources.
- Environmental gradients – where broad latitudinal and elevational gradients capture broad niche or bioclimatic gradients that maximize the ability of species to track large-scale environmental changes over the shortest possible distances.
- Connectivity – the mechanism that enables species to track large-scale environmental changes through a series of landscape-level, intra- and inter-generational movements. Here, connectivity is measured according to Theobald et al. (2012) *Cons. Lett.* doi: 10.1111/j.1755-263X.2011.00218.x

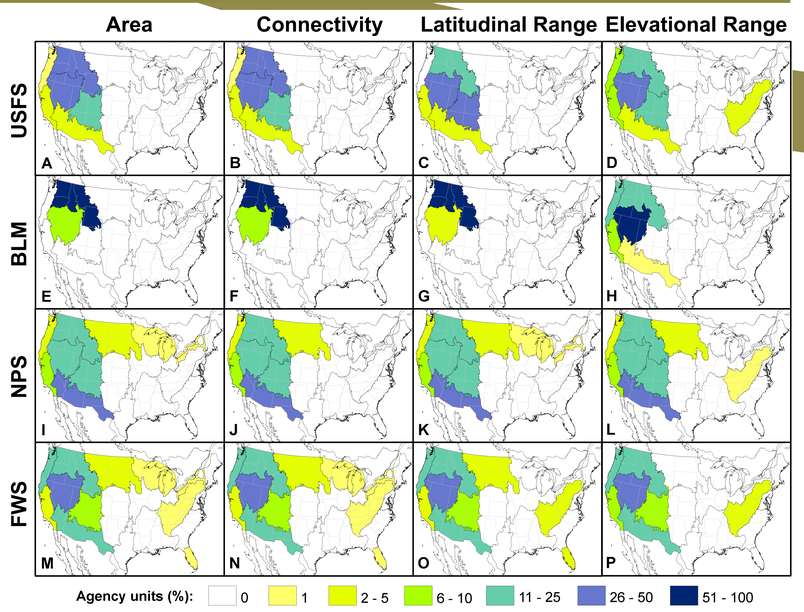
Partnership opportunities vary tremendously by landowner, both ideologically based on mission alignment, and also geographically at large-spatial scales based on the degree to which management decisions are centralized (e.g., federal agencies) vs. decentralized (e.g., county governments) among individual management units.

We focus our analysis here on federal lands managed by the USFS, BLM, NPS, and FWS because these four agencies collectively mange c. 65% of conservation lands in the contiguous US (c. 35% of all area), share similar missions to protect natural resources, and thus have the potential to form strong, new partnerships under LCCs.

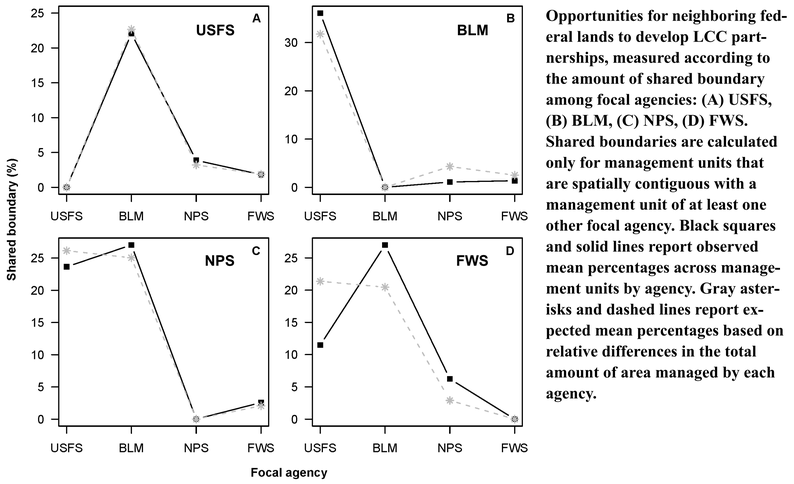
Results & Discussion



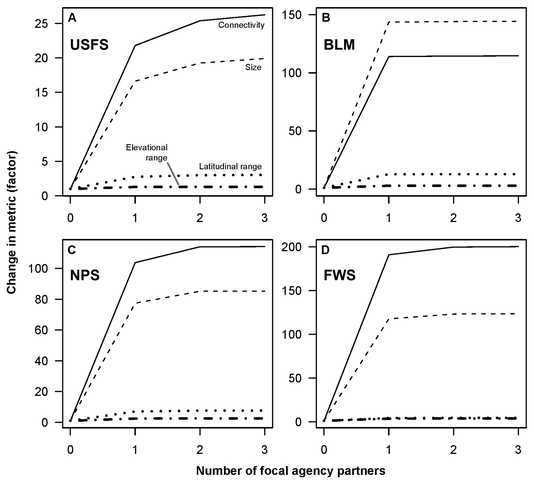
Map of the contiguous US with Landscape Conservation Cooperatives (LCCs; names in black labels), lands managed by major federal agencies (USFS = US Forest Service, BLM = Bureau of Land Management, NPS = National Park Service, FWS = Fish & Wildlife Service), and other protected areas. Although important LCC partnerships undoubtedly exist among other landowners, the large-scale conservation opportunities afforded by USFS, BLM, NPS, and FWS are foundational to understanding the value of local partnerships, and ultimately the adequacy of our existing protected areas network in promoting climate change adaptation.



LCCs and major large-scale partnership opportunities for increasing the effective size, latitudinal range, elevational range, and structural connectivity of individual management units. Results report the top 100 partnerships for each agency x metric, expressed as a percentage by LCC: (A-D) USFS, (E-H) BLM, (I-L) NPS, (M-P) FWS; (A, E, I, M) size, (B, F, J, N) connectivity, (C, G, K, O) latitudinal range, (D, H, L, P) elevational range.



Opportunities for neighboring federal lands to develop LCC partnerships, measured according to the amount of shared boundary among focal agencies: (A) USFS, (B) BLM, (C) NPS, (D) FWS. Shared boundaries are calculated only for management units that are spatially contiguous with a management unit of at least one other focal agency. Black squares and solid lines report observed mean percentages across management units by agency. Gray asterisks and dashed lines report expected mean percentages based on relative differences in the total amount of area managed by each agency.



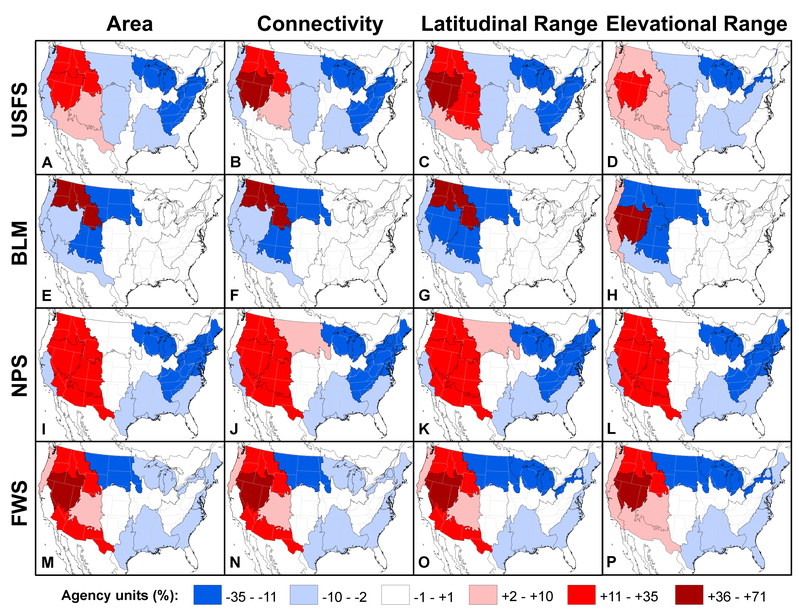
Increases in landscape metrics with 1 to 3 inter-agency partners (i.e., adjacent neighbors), relative to a baseline where units are managed only under intra-agency partnerships. Landscape metrics include protected area size (dashed), latitudinal range (dotted), elevational range (dashed-dotted), and structural connectivity (solid). Results are obtained by dissolving shared management boundaries for four focal federal agencies in the contiguous US: (A) USFS, (B) BLM, (C) NPS, (D) FWS. Numbers report means across all management units.

10 of the 16 LCCs (62%) in the Lower 48 have >1 major inter-agency partnership opportunity.

Most occur in the West and eastern Appalachians, but percentages vary by agency x metric.

This suggests that focal agencies may coordinate their management partnerships to balance large-scale opportunities for climate change adaptation at both regional and national scales.

Such coordination will invariably involve certain tradeoffs where – within each focal agency – some management units are altruistic so that others may realize partnership benefits.



Deviations (observed minus expected) of the top 100 partnership opportunities by LCC. Expected percentages are calculated separately by agency based on the total number of management units: (A-D) USFS, (E-H) BLM, (I-L) NPS, (M-P) FWS; (A, E, I, M) size, (B, F, J, N) connectivity, (C, G, K, O) latitudinal range, (D, H, L, P) elevational range. Positive values identify LCCs where each agency has a disproportionately large number of partnership opportunities with other focal agencies. Negative values are where each agency is underrepresented relative to random expectations.

At maximum partnership potential (3 inter-agency partners), the average effective sizes of management units increase by 20-144x, gradients by 3-13x (latitudinal) and 2-4x (elevational), and connectivity by 26-200x.

Most of these gains are attained when individual management units partner with just one other focal agency.

Hence, although fewer than 10% of focal agency units share borders with one another, considerable opportunities exist for single conservation partnerships to increase key landscape metrics that favor species' abilities to track changes in climate.

In summary, species require broad environmental gradients and large, connected areas if they are to move in response to large-scale environmental drivers like climate change.

LCCs and major federal landowners can encourage these movements by developing strategic inter-agency partnerships.

The essence of these partnerships is simple: neighboring lands coordinate management practices across shared borders to increase the effective sizes, latitudinal and elevational gradients, and connectivity of their individual management units.

Future work will expand the analyses to consider other landowners, including state and private.